Robot-assisted thoracic surgery in Colombia: a multi-institutional initial experience

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Abstract

Background: robotic assisted videothoracoscopic surgery (RVATS) adoption has increased worldwide from 3.4% in 2010 to 17.5% in 2015. But in Latin America the literature is limited to a report of a series of 10 patients who underwent RVATS lobectomy one case report of an RVATS thymectomy from Brasil.

Methods: this is a retrospective review of all RVATS performed in Bogotá Colombia since 2012. A single thoracic surgeon (R.B) performed all the operations at 3 institutions: Clínica de Marly, Fundación Clínica Shaio and Instituto Nacional de Cancerología. Preoperative, intraoperative, postoperative and pathology report variables were included. Patients were analized in 3 groups: patients who were subject to robotic RVATS pulmonary resections, patients who were subject to RVATS mediastinal surgeries and the patients who were subject to other RVATS procedures. Descriptive statistics were used to report the median and interquartile range (IQR) of the continuous variables, and number and percentage were used to describe categorical variables. The association between total operative time and the year the surgery was analized usign a linear regression model.

Results: 47 patients underwent RVATS pulmonary resections. 72.3 % (n=34) of this patients underwent a RVATS lobectomy, the median total operative time was 220 minutes (IQR 200 to 250), 6.4% (n=3) had intraoperative complications, and the most frequent histologic diagnosis was adenocarcinoma (n=24, 51.1%). Of 18 patients who underwent RVATS mediastinal surgeries, 50.0 % (n=9) had RVATS thymectomy, the median total operative time was 195.5 minutes (IQR 131 to 221) and two patients (11.1%) had intraoperative complications. The linear regression model of the association between total operative time and the year the surgery was performed showed a 10.3 minute reduction per year (p 0.006).

Conclusions: this is the second series of RVATS published in Latin America and the first published in Colombia, with comparable perioperative results to other

reports.

Introduction

Minimally invasive surgery (MIS) has demonstrated substantial benefits compared with thoracotomy and sternotomy for thoracic procedures, this benefits include lower complication rates, shorter hospital length of stay (LOS) and faster recovery. Robotic-assisted videothoracoscopic surgery (RVATS) is the most recent MIS technique and compared with other MIS platforms, RVATS provides three dimensional visualization, seven degrees of freedom of motion and improved visual haptics (1).

In 2015, more than 6000 robotic lobectomies were performed in the United States, and more than 8600 were done worldwide(2). In contrast, the latin american literature is scarse, there is a series RVATS pulmonary lobectomies reported from Brasil with 10 patients and good perioperative outcomes but long term results are pending (3) and one case report of robotic assisted thymectomy also from Brasil (4). In Colombia the first robotic lobectomy was performed in 2012 (5) when the da Vinci Robotic System was aquired, since then 69 RVATS have been performed.

The objective of this article is to report the first experience with RVATS for different thoracic pathologies published in Colombia and the largest series publishes in Latin America.

Methods

This is a retrospective review of all the RVATS performed in Bogotá Colombia since 2012 when the first Da Vinci robot was aquired. A single thoracic surgeon (R.B) performed all the operations at 3 institutions, Clínica Marly, Clínica Shaio and Instituto Nacional de Cancerología. The operations were completed with the patients under general anesthesia and lung isolation, using either a 3-arm or 4-arm

robotic technique. All the patients who underwents RVATS from april 2012 to august 2018 were selected. The clinical histories, surgical descriptions and pathology results were reviewed and the variables were collected in a pre-design format.

Preoperative variables included age in years and sex. Intraoperative variables included lesion location and resection type; docking time, console time and total operative time in minutes (min). The docking time was defined as time from the first skin incision to the start of driving the robotic arm while seated at the console, the console time was defined as the time that principal surgeon drove the robotic arm while seated at the console and performed the intrathoracic procedures and total operative time was measured from the first skin incision to skin closure. Blood loss in mililiters (mL), convertion rate to thoracotomy or sternotomy and intraoperative complications were also measured. Postoperative variables collected included chest tube duration in hours (Chest tubes were removed during the hospital stay as soon as the drainage was less than 100 mL/day and no air leaks were present), postoperative complications, days of hospital LOS, in hospital mortality, 90 day mortality and follow up time in months. Lastly the variables collected from the pathology report were histology of the tumor or lesion, median tumor size in milimeters (mm) and the stage of the disease for malignant pathologies complemented with images and clinical history.

Patients were divided in 3 groups: patients who were subject to robotic RVATS pulmonary resections, patients who were subject to RVATS mediastinal surgeries and patients who were subject to other RVATS procedures which include plication of the diaphragm, sympathectomy and resection of a thoracic wall lesion. The variables were analized in each group separately.

The data were collected using Excel software (Microsoft Corp) and analyzed using STATA 14. Descriptive statistics were used to report the medians and interquartile range (IQR) of the continuous variables were IQR lower value corresponds to the 25% quartile and the higher value corresponds to the 75% quartile. Number and percentage were used to describe categorical variables. The association between

total operative time and the year the surgery was performed was analized usign a linear regression model.

Results

RVATS pulmonary resections

Between april 2012 and august 2018 a total of 69 patients underwent RVATS with the da Vinci Surgical System. From the 47 patients in which RVATS pulmonary resections were performed, the median age was 61 years (interquartile range (IQR 50 to 73) and 27.7% (n=13) were men. The data for this group is presented in table 1. Tumor location was most prevalent in the right upper lobe (n=15, 31.9%), 72.3 % (n=34) of patients underwent a RVATS lobectomy, and the remainder had segmental (n=2, 4.3%) or nonanatomic resections (n=5,10.6%). Two bronchoplasties were performed for two patients with a neuroendocrine tumor and a metastasic lesion from thyroid cancer. The median total operative time was 220 minutes (IQR 200 to 250), the median console time was 125 minutes (IQR 110 to 150) and the median blood loss was 100 ml (IQR 80 to 100). There were no convertions to thoracotomy and 6.4% (n=3) had intraoperative complications, that consisted in intropeative bleeding that was adequeately controled. The median chest tube duration was 48 hours (IQR 48 to 67) and the median lenght of hospital stay was 3 days (IQR 2 to 4). The most frequent histologic diagnosis was adenocarcinoma (n=24, 51.1%), followed by benign lesions (n=9, 19.2%) and neuroendocrine tumors (n=5, 10.6%). The majority of patients had stage I disease (n=24, 64.9%). There was no inhospital mortalitiy and there was one death at 90 days follow up. The mean follow-up time was 29 months (IQR 12 to 55) and during the follow-up time 6 (12.8%) patients died of metastasic disease. Two patients with marginal pulmonary function (FEV1 49% and 26%) underwent a RVATS lobectomy with good results.

RVATS mediastinal procedures

There were 18 patients who underwent RVATS mediastinal surgeries. In this group the median age was 50 years (IQR 39 to 59) and 22.2% (n=4) were men. The data for this group is presented in table 2. Surgical main location was the anterior mediastinum (n=11, 61.1%) and 50.0 % (n=9) of patients underwent a RVATS thymectomy, 7 patients had miastenia gravis and 2 patients had thymomas. There were two esophageal leiomyoma resections and one bronchogenic cyst resection. The median total operative time was 195.5 minutes (IQR 131 to 221), the median console time was 107.5 minutes (IQR 95 to 125) and the median blood loss was 50mL (IQR 20 to 90). There were no convertions to sternotomy and two patients (11.1%) had intraoperative complications caused by bleeding. The median lenght of hospital stay was 2.5 days (IQR 2 to 3) and the median chest tube duration was 48 hours (IQR 24 to 68). There ware no in hospital mortalities or 90 day mortalities and the mean follow-up time was 14 months (IQR 5 to 24). There were no deaths during the follow-up time.

Other RVATS procedures

There were four patients who underwent other type of surgeries that consisted of two plicatures of the diaphragm, one sympathectomy and one thoracic wall resection of a patient who had a metastasic lesion from multiple mieloma (table 3). There were no convertions, intraoperative complications, postoperative complications, in hospital mortality or 90 day mortality among this patients.

Time trend for surgery time

We performed a linear regression to analize the association between total operative time and the year the surgery was perfomed (figure 1). This figure shows a 10.3 minute reduction per year of surgery with a 95% confidence interval between 3.1 minutes and 17.5 minutes and a p values of 0.006.

There were seven patients who had missing data on in hospital mortality because they were either lost to follow up or had not completed the 90 days of follow up at

the moment of data collection and one patient has missing data on blood loss.

Discussion

In 2015 RVATS lobectomies accounted for 17.5% of elective lobectomies which represents a fivefold increase in RVATS adoption rate from the 3.4% of lobectomies in 2010 reported by Kent and colleagues (6). The increased adoption of RVATS appears to result from a shift from the open approach, given that the rate of video assisted thoracoscopic surgeries (VATS) have remained unchanged at approximately 40% (6). The reasons for this limited acceptance of VATS are multifactorial and include restricted vision secondary to two dimentional nature of conventional laparoscopes, and limited range of motion of instruments due to size and design. RVATS has been studied to overcome these limitations because it offers several technical advantages such as three dimensional high definition field of view, tremor filtration, augmented dexterity, and better ergonomics (7–10). Patients undergoing VATS suffer from fewer complications, have less pain and blood loss, and recover faster compared to patients undergoing thoracotomy for different thoracic pathologies (7). In multivariate analysis, VATS was associated independently with a reduced risk of complications (11). Several restrospective comparative studies published between 2008 and 2018 have demostrated that RVATS lobectomy is safe and effective and has 30-day mortality comparable to that of VATS (12–15) and better outcomes compared to thoracotomy (6,16,17) with similar long term survival (18,19). When single large national and statewide databases are analized, RVATS yields lower morbidity (6) and lower mortality than both thoracotomy and VATS (16,17). Two studies found lower convertions rates with RVATS compared to VATS (14,15). and some studies suggest that RVATS has better outcomes in patients with marginal pulmonary function (20) and that is safe for older patients (21). In our series two patients with marginal pulmonary function had RVATS lobectomy with good results. Some systematic reviews and metanalysis of retrospective observational studies found that perioperative morbidity and mortality were similar between patients who underwent lung

resections by RATS and those who underwent VATS (8,9,11), with a tendency towards shorter hospitalization time and drainage duration with RVATS(7).

In this series we present the first report of RVATS in Colombia and the second and largest series reported so far in Latin America. RVATS lobectomies were performed using the method described by Dylewski (22) and the instrument position is shown in figure 2. Compared to the first series reported in Brasil, we have a higher female rate and the age distribution is similar, but we can not compare the perioperative results because they did not report median values of these variables. Most of their patients had chest tube drainage from 24 to 48 hours and lenght of hospital stay less than 48 hours, which have concordance with our results (3). Our results are comparable to those reported in the international literature, with the exception of sex distribution because our series has more females compared to others (9). Our total operative time is also comparable, the mean operative time in our study was 185 min and in the literature it ranges from 107 to 241 minutes (8,9). As we know, there is a steep learning curve for RVATS, and operating time has been shown to significantly improve after the initial learning period (23,24), in this report we analized the total operative time by the year in which the surgical procedures were performed and the mean total time decreased during the six years of the estudy (figure 1). Convertion rate was 0% as reported in many series (25,26). Postoperative hospital LOS, duration of chest tube drainage, perioperative mortality, perioperative morbidity and blood loss in this series were comparable to those previously reported (8,9,27).

Most surgeons offered RVATS to clinical stage I or II non small cell lung cancer, Veronesi et al. limited the maximum size to five centimeters, Cerfolio et al. extended the indications to include larger size or preoperative chemoradiation and other surgeons allowed more advanced cases (28). Recent reports showed that more complicated cases needing bronchoplastic surgery were feasible for robotic surgery (29,30). In this series most of the patients with lung cancer diagnosis had stage I disease and we also report more complex surgical procedures such as two bronchoplasties with adequate perioperative outcomes.

Mediastinal tumors are good candidates for robotic surgery. Several articles have shown that RVATS mediastinal mass resections including thymectomy are as good as VATS (31) and superior to transsternal resection, reducing intraoperative blood loss, postoperative complications, and hospital length of stay (32–34). RVATS for thymic epitelial tumors achieved comparable long-term oncologic outcomes (35). There are two metanalisys (36,37) and one systematic review (38)comparing RVATS and VATS for thymectomy which show no difference with respect to conversion rate, hospital LOS, or postoperative morbidity. One metanalisys showed a tendency towards less hospital LOS and less chet tube drainage days with RVATS compared to VATS, but the power of the study was low, only seven studies were included (37)

This series of RVATS for mediastinal surgeries have similar results compared with the literature. In the metanalysis by Buentzel et al the operation time ranged from 97 to 224.2 minutes and in our study the mean total operative time was in this range (37). As in this series, most of the studies had 0% convertion rate, and short lenght of chest tube duration (37). The hospital LOS in the literature ranged from 3.7 to 9.6 days, in this series this time was shorter with a mean of 2.5 days (37). In this report patients had minimum blood loss and none postoperative complications, simliar to other studies (39,40).

The presented series brings to the thoracic robotic literature the second series of RVATS published in Latin America and the first published in Colombia, with comparable peritoperative results to other reports. We also present two patients who underwent RVATS bronchoplasties, showing that more complex procedures are feasible. And two patients with marginal pulmonary function that made the open approach impossible and the VATS approach very difficult, in this patients the RVATS optimization of precision and postoperative outcomes made the pulmonary resection possible and good postoperative course.

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Figures

Figure 1. Linear regression showing a 10.3 reduction in total operative time by years of RVATS experience.

Figure 2. Instrument position for a RVATS pulmonary lobectomy with a three arm surgical technique.

Tables

Table 1. RVTAS pulmonary resections: patient characteristics and perioperative results.

Table 2. RVATS mediastinal lesion resection: patient characteristics and perioperative results.

Table 3. RVATS other procedures: patient characteristics and perioperative results.